Characterizing the Environmental Features of a Region for a Community-Level Health Study of Breast Cancer

Steven J. Melly (1),[1] Yvette T. Joyce (2), Julia G. Brody (1)
(1) Silent Spring Institute, Newton, MA; (2) Applied Geographics, Inc., Boston, MA

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We have used a geographic information system (GIS) as the central management and analysis tool in the Cape Cod Breast Cancer and Environment Study. A team of public health and environmental researchers working together with GIS specialists have developed methods for using GIS data from multiple sources with different scales to study environmental factors that might be relevant to breast cancer incidence. This demonstration project will illustrate how we dealt with differences in source scales to estimate the number of households within specified distances of environmental features. Data on pesticide use on Cape Cod will be used to demonstrate how we estimated exposure categories using the GIS. We will also illustrate how researchers with limited GIS background have been able to access and analyze GIS data using ArcView. We will discuss our results from the community-level analyses in the first phase of the study, and our plans for using GIS in a case-control study beginning in the fall of 1998.

Silent Spring Institute is a nonprofit research institute dedicated to investigating the links between women's health and the environment. Since 1994 Silent Spring has been leading a multi-disciplinary team of investigators in a state-funded study of breast cancer incidence on Cape Cod. The team includes researchers from Tufts, Harvard, and Boston Universities as well as GIS specialists from Applied Geographics, Inc., a Boston-based consulting firm.

When the Cape Cod Study began in 1994, Massachusetts Cancer Registry data indicated that age-adjusted breast cancer incidence was significantly higher in a majority of Cape Cod towns than in the state as a whole. Alarmed by these statistics, citizen activists, public health officials, and researchers began sifting through possible explanations. Were high breast cancer rates due to characteristics of women who live on the Cape, or something about the environment?

In our research we focused on two environmental factors that might be different on the Cape from the rest of the state: exposure to drinking water impacted by waste water, and exposure to pesticides through air, dust, and water. Nearly all of the drinking water on the Cape comes from shallow wells, and all waste water is disposed of into the ground because the surrounding waters are a marine sanctuary. Pesticides may have been more heavily used on the Cape because of the large number of cranberry bogs and golf courses and because the native trees are more susceptible to pests.

Using ARC/INFO and ArcView on a Sun workstation, we created a comprehensive GIS for Cape Cod. We had excellent sources of data from the Cape Cod Commission, MassGIS from the Executive Office of Environmental Affairs, and the US Geological Survey. We also digitized data from paper maps that included areas treated with pesticides for tree pests. Figure 1 illustrates some of the pesticide use areas we were able to

[1] Steven J. Melly, Silent Spring Institute, 29 Crafts St., Newton, MA 02158 USA; (p) 617-332-4288; (f) 617-332-4284; E-mail: melly@silent.shore.net

map for the town of Sandwich. We wanted to answer the question: how many women might have been exposed to these pesticide use areas at different points of time? We had land use data from different points in time and parcels data from the 1990s. Because most of the residential land on the Cape is developed as single family homes, we proposed using residential parcels as a surrogate for number of households and, ultimately, number of women.

A challenge we faced was using coverages with different source scales. If we simply identified parcels that intersected residential land use polygons from a specific year, we would include many parcels that were not actually residential because of the differences in source scale. We used two approaches to eliminate the extra parcels. We used attributes in the parcels coverages to eliminate parcels we knew could not be residential, such as wetlands and undevelopable land (Figure 2). We then eliminated any parcels that intersected less than one-tenth of an acre of residential land use (Figure 3).

One possible problem with this approach involves using data sources from different points in time. Does it make sense to use 1990 parcels with 1951 land use data? We reasoned that the only situation when this would be a problem is if previously developed land were redeveloped into smaller house lots. An analysis of land use change from 1951 to 1990 indicates that the vast majority of residential development occurred in previously forested areas. The land use data were broken down according to lot size. We found that very little residential land with less than ½-acre lots in 1951 was later converted to smaller lots, and concluded that it was acceptable to work with the two coverages together.

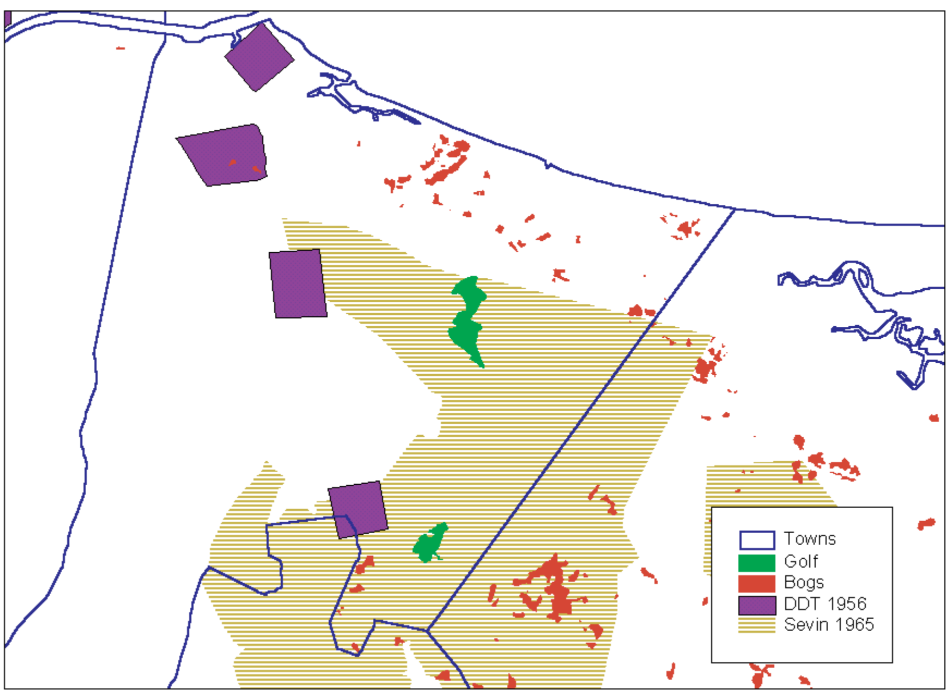

Figure 1 Pesticide use areas in Sandwich, MA. We were able to map large-scale pesticide use areas including cranberry bogs, golf courses, and areas sprayed for tree pests.

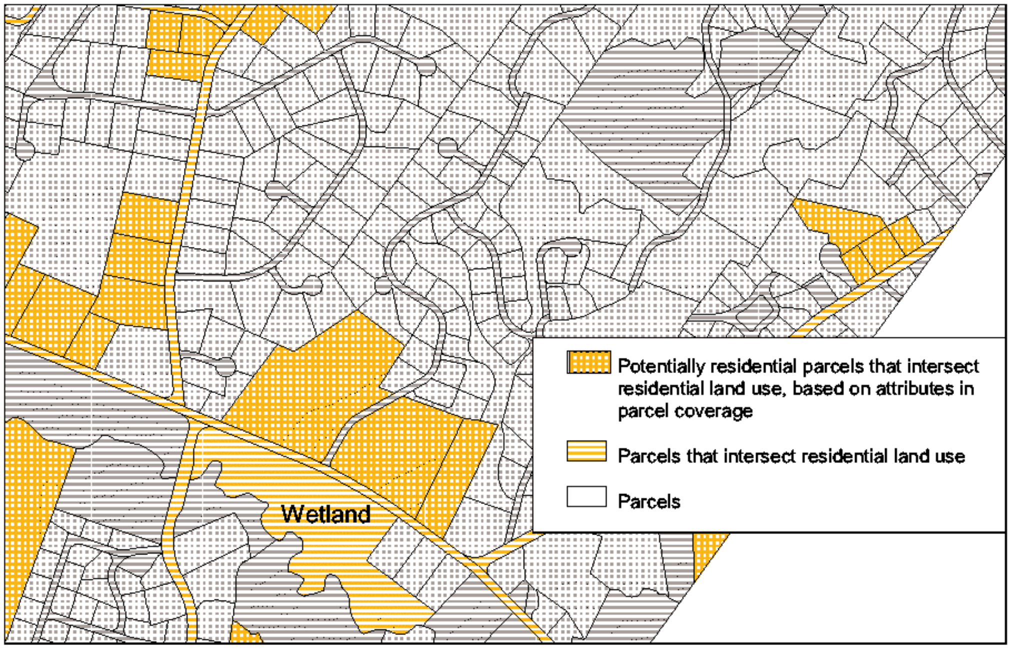

Figure 2 Estimating potentially exposed populations. In order to estimate number of households near pesticide use areas we first identified parcels that intersect residential land use, then used codes from the Department of Revenue to eliminate parcels that could not be residential (such as the wetland, shaded with horizontal stripes).

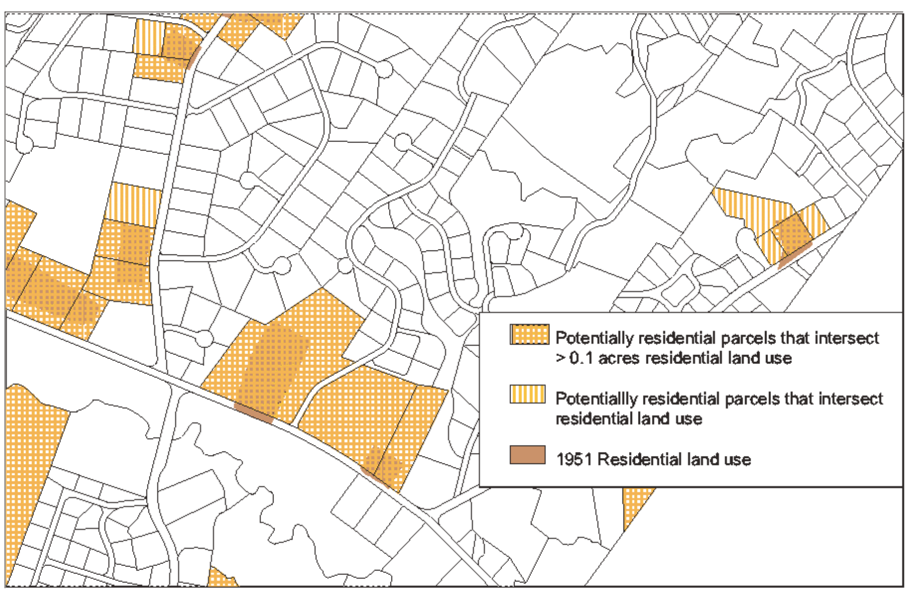

Figure 3 Refining estimates of exposed populations. We further refined our estimates of numbers of households by eliminating the parcels that intersected less than one-tenth of an acre of residential land, shown here shaded with vertical stripes.

Members of our team from Applied Geographics used Arc/Info AML (Arc Macro Language) programs to calculate the distance of residential parcels from various pesticide use areas and add the result to the attribute table. We could then identify residential parcels within a specified distance of pesticide use areas (e.g., 1,300 feet for aerial spray operations). Ultimately we used this information to classify the census block groups of the Cape into high and low exposure categories for the various types of pesticide uses we studied (Figure 4).

We developed this exposure assessment in a community-level study using cancer registry data. We did not see an association between breast cancer incidence and these exposure categories. This is perhaps not surprising given the limitations of a community-level study. We did not have information about the residential histories of the women in the cancer registry files, and we confined our analysis to block groups. The areas most exposed to pesticides are likely to be much smaller than block groups. We plan to overcome these limitations by conducting a case-control study in the near

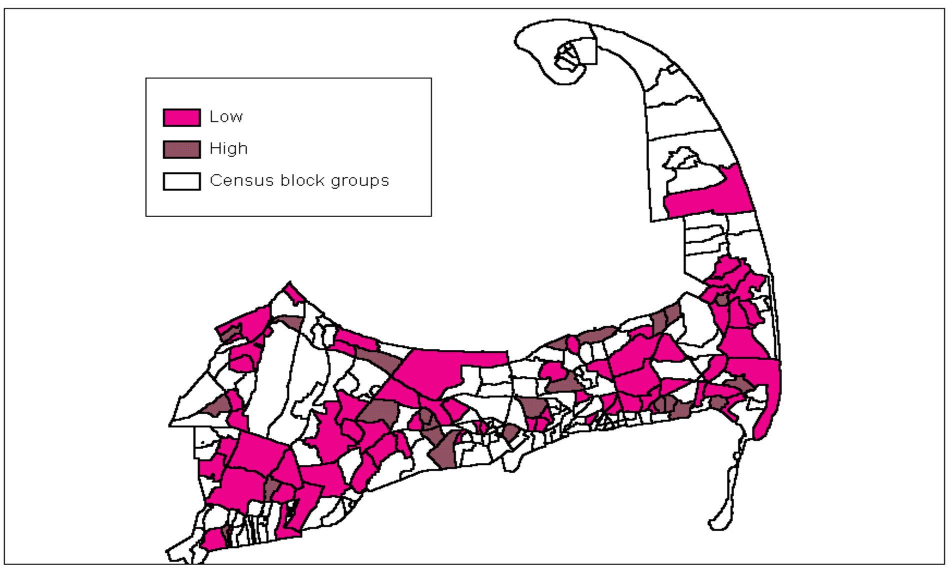

Figure 4 Exposure groups for cranberry bogs. We classified the census block groups according to the number of women potentially exposed to areas of large-scale pesticide use.

future. The study will be designed from the start to incorporate the use of GIS to develop exposure variables.

Acknowledgments

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